"PROCESS AND APPARATUS FOR THE ELECTROGALVANIC COATING OF METAL ITEMS"

The present invention relates to processes and apparatuses for the electrolytic deposition of protective coatings on metal items, typically the coating with zinc of screws and the like. Reference will be made hereafter to such an application, while it is clear that what is being said is also applicable to other types of protective and/or decorative coating with other metals and applied to any kind of item.

It is known that conventional zinc-coating plants essentially consist of a sequence of operating stations where the screws, loaded into a perforated barrel, undergo the various treatments required to obtain the protective coating through a process well known to those skilled in the art. By way of example, reference will be made to a plant having an operative capacity of 1800 kg/hour of screws, for a zinc-coating 12 μm thick. Such a plant provides a sequence of phases/stations as follows:

- N.2 chemical cleaning stations
- N.2 washing stations
- N.3 pickling stations
- N.2 washing stations
- N.1 electrochemical cleaning station (with a 16V/1000A rectifier)
- N.2 washing stations
- N.12 electrochemical zinc-coating stations (each with a 16V/1000A rectifier)
- N.2 washing stations
- N.1 neutralization station
- N.1 blue passivation station
- N.1 washing station
- N.1 yellow passivation station
- N.1 washing station
- N.1 loading/unloading station
- N.2 drying stations

This results in a plant with 34 stations, with a total volume of treatment liquids of about 40.000 liters and a length of over 40 m.

Since with this conventional process and plant the items are moved from one station to another by moving the barrel that contains them, there are a plurality of serious drawbacks that can be summarized as follows:

1. transporting the items in the barrel from one station to another implies also carrying a large amount of liquids that have to be purified since the barrel, due to its conformation, causes a very strong carry-over in the passage from one station to another, be it full of items or empty, which makes necessary to use a large amount of washing water and chemical products;
2. the huge amount of liquids and products required in the various phases of the process have to be purified;
3. the necessity of frequent analytical checks of the chemical solutions;
4. a large volume of highly polluting liquids in the open that constantly emit harmful vapors and toxic gases that also must be purified;
5. a great amount of space taken up;
6. the necessity of a very frequent mechanical maintenance due to the treatment plant system;
7. the necessity of a labour force for loading/unloading and supervision of the phases;
8. a very quick deterioration of the plants and accessories connected thereto and of the adjacent structures.

Therefore the object of the present invention is to provide a process and apparatus which are free from the above-mentioned drawbacks. This object is achieved by means of a process and apparatus that provides the use of centrifuge drums instead of barrels, a treatment phase and the subsequent washing in the same station, as well as the centrifugation of the items prior to the passage to another station or to the successive treatment phase in the same station.

A first great advantage of the present invention stems from the fact that rather than moving the items to be treated from one chemical station to another by means of bridge cranes that transport the barrels, they are the items to be treated

that remain for several treatment cycles inside the same centrifuge because the liquids are moved, by filling and emptying the apparatus through a hydraulic pumping system. The fact of centrifuging the items between one treatment and another therefore implies a very low consumption of chemical products and water in that, thanks to the centrifugation, they are completely recovered.

A second significant advantage is given by the fact that whereas between one phase an another of the known process there are large carry-overs that cause the pollution of the chemical solutions with subsequent necessity for a frequent intervention to restore them, otherwise the treatment is not carried out correctly and this may cause the rejection of the treated items, in the new system all of this is not necessary because thanks to the centrifugation of the items between one chemical phase and another the pollution can not occur.

Still another important advantage is the greatly reduced environmental impact and the lower cost of the plant, since it is not required to provide complicated and expensive water and air purification systems given that there are no highly polluting liquids used in the open.

Finally a further advantage is given by the smaller space taken up by the plant, thanks to the lower number of stations, and by the decreased necessity of labour force because the loading and unloading systems for centrifuges are 100% automated since some time and they guarantee a great reliability. By way of comparison, you can consider that to make a plant according to the present invention having the same operative capacity of the conventional plant mentioned above the following stations are sufficient, for an overall length of about 30 m:

- N.1 loading station
- N.2 chemical cleaning stations
- N.3 pickling stations
- N.1 electrochemical cleaning station (with a 16V/1000A rectifier)
- N.6 electrochemical zinc-coating stations (each with a 16V/1000A rectifier)
- N.1 passivation station
- N.2 drying stations
- N.1 unloading station

In brief, the process and apparatus according to the invention allow to obtain the same operative capacity with a plant that requires 70% less liquids and chemical substances, has 50% less stations, with an automatic handling without operator and with a very low environmental impact.

Further advantages and characteristics of the process and apparatus according to the present invention will be clear to those skilled in the art from the following detailed description of an embodiment thereof, with reference to the annexed drawings wherein:

Fig.1 is a diagrammatic front view of a plant according to the present invention, as in the above-mentioned comparative example;

Fig.2 is a diagrammatic top plan view of the plant of fig.1;

Fig.3 is a diagrammatic side view of an apparatus corresponding to a station of the plant above; and

Fig.4 is a diagrammatic front view showing in greater detail the centrifuge of one of the stations provided with a rectifier.

With reference to figures 1 and 2, there is seen that a plant according to the present invention consists of a sequence of aligned stations A for the chemical and electrochemical treatments, the latter where rectifiers R are provided, with an automatic loading station L at the inlet and an automatic unloading station U at the outlet, the latter being preceded by two drying stations A'.

The items to be treated are contained in perforated cylindrical drums D open at the top (similar to a washing machine drum), and said drums D are automatically moved from one station A to another by means of carriages C that run on rails B extending above the stations along the whole length of the plant, from the loading station L to the unloading station U.

The use of these open drums D, instead of the conventional barrels closed by a door, allows to carry out in a completely automatic way the loading and unloading of the items in the plant end stations with a great saving of labour force as well as with no risks to the health of the operators.

In figures 3 and 4 there are illustrated the members that make up one of the above-mentioned stations A, in particular one of the stations for the

electrochemical zinc-coating treatment.

Such a station includes a centrifuge F, closed by a top lid E, wherein a motor M' rotates a drum D that has been vertically introduced into centrifuge F by one of the above-mentioned aerial carriages C. Upon closure, centrifuge F can be inclined to about 45° around an axis X by means of a motor M, while retaining the electrical connection to a rectifier R as well as an hydraulic connection.

In fact the treatment liquids are delivered to and drained from centrifuge F through respective delivery G and drain H pipes that converge into an hydraulic connector S extending from the bottom of centrifuge F. The delivery pipe G comes from an upper tank T located on a scaffolding K at an elevated position with respect to centrifuge F, whereas the drain pipe H leads to a lower tank T' located lower than centrifuge F under said scaffolding K.

The two tanks T, T' are in turn hydraulically connected with the help of a pump P, that allows to return the recovered and purified liquids from the lower tank T' to the upper tank T. Other piping, pumps and valve means not illustrated are also provided for the delivery and drain of liquids in the two tanks.

In the light of the description above, the process according to the invention and the operation of the relevant apparatus are readily understood.

The items to be treated are automatically loaded in a drum D and undergo in sequence the conventional phases of chemical and electrochemical treatment in the different stations A, and are finally unloaded still in an automatic way at the plant outlet.

The main novel aspect of the present process is given by the fact that it is not indispensable to move the items from one station to another to carry out the various phases, since the alternation of the liquids delivered to the centrifuge allows to carry out in the same station more treatments alternating with centrifugations without moving the drum. In theory it would even be possible to concentrate all the phases in a single station, however such an extreme solution would make sense only for an extremely small production that would not justify the cost of a whole multi-station plant.

All the intermediate solutions between the complete development of the

plant illustrated in fig.2 and the concentration of the phases in a single station are obviously also possible, whereby the number of stations for each phase may vary according to the needs. In other words, the process typically consists of the following steps:

a) introducing the drum containing the items into a centrifuge;
b) delivering a first chemical treatment liquid to the centrifuge;
c) carrying out the treatment;
d) draining said first chemical treatment liquid from the centrifuge;
e) carrying out a centrifugation of the items to recover said liquid;
f) delivering washing water to the centrifuge;
g) carrying out the washing;
h) draining the washing water from the centrifuge;
i) carrying out a centrifugation of the items to recover said water;
j) transferring the drum to another station, or repeating the preceding steps with another chemical treatment liquid.

It should be noted that the mere fact of carrying out the washing subsequent to a chemical treatment phase in the same station where the treatment has been carried out already allows to significantly reduce the number of stations. Moreover, the centrifugation subsequent to every treatment or washing allows to recover the liquids thus reducing the consumption thereof, as well as to prevent the problems of liquid carry-over from one station to another, which also prevents the environmental pollution.

In order to optimize the use of treatment liquids it is preferable that the treatment takes place with the centrifuge inclined at about 45°, whereas for the centrifugation it is better to return the drum to the vertical position. Therefore, in such a case, the steps listed above would be supplemented with the inclination of the centrifuge prior to the treatment and to the washing (steps "c" and "g"), as well as with the returning of the centrifuge to the vertical position prior to the centrifugations (steps "e" and "i").

It is clear that the above-described and illustrated embodiment of the process and of the apparatus according to the invention is just an example

susceptible of various modifications. In particular, the members making up the apparatus may be replaced by other members that are mechanically equivalent or modified according to specific needs; for example, the shape of the centrifuges and of the corresponding drums may be different, the centrifuges may be inclined at a different angle and/or around an axis that is differently arranged, and so on.

Similarly, the hydraulic circuits that control the flows of liquids to and from a centrifuge may change, for example by providing more tanks and/or more pumps, or a single tank that feeds several centrifuges through valved manifolds and so on.